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COVERED CONDUCTOR, SOLDERING METHOD USING THE COVERED CONDUCTOR, AND ELECTRIC ACOUSTIC CONVERTER

TECHNICAL FIELD

[0001] The present invention relates to an enameled wire for use as a coil of small and light-weight electro-acoustic ~~transducer~~ transducers such as a micro speaker, a receiver, a sounder or the like, built in a portable telephone unit or the like mobile communication apparatus. The present invention also includes a method of soldering the enameled wire, as well as an electro-acoustic transducer employing ~~it~~ the wire.

BACKGROUND ART

[0002] A conventional technology used for manufacturing an electro-acoustic transducer is described with reference to FIG. 5 through FIG. 7.

[0003] FIG. 5 shows a cross sectional side view of a sounder for use in a mobile communication apparatus. FIG. 6 is a cross sectional view of an enameled wire for forming a coil, which is a key portion of the sounder. FIG. 7 is a perspective view used to describe how the enameled wire is soldered by ~~means~~ virtue of laser irradiation.

[0004] Referring to FIG. 5, an enameled wire 1 is wound to form a coil 1a disposed on a plate 3 having a ~~center~~ central pole 2. A terminal 4 is resin-molded in a bottom case 4a with at least a soldering portion of the terminal exposed outside of the bottom case. The terminal is provided at the exposed portion with a land for connection with the enameled wire 1. A ring-shaped magnet 5 is fixed on the plate 3. Above the magnet 5 is a diaphragm 6, which is disposed with a certain clearance from the magnet 5. A small piece of magnetic material is attached on the diaphragm 6 at ~~the~~ a center of the diaphragm. An upper case 7 is provided with a sound radiation hole 8.

[0005] Enameled wire 1 constituting the coil 1a is described with reference to FIG. 6. ~~There~~ ~~is~~ The enameled wire 1 includes a core wire 1b of copper or ~~an~~ a copper alloy, which is covered around ~~the~~ an outer surface thereof with an insulating film 1c, and a hot-melt layer 1d ~~is covering~~ covers the insulating film 1c.

[0006] During winding of the enameled wire ~~is wound~~ around the ~~center~~ central pole 2 for forming the coil 1a, the hot-melt layer 1d is softened or melted by hot air blown thereto, or by ~~other means~~ another manner. When ~~the~~ heating with hot air is stopped, the hot-melt layer 1d solidifies again, and as a result the enameled wire 1 stays in a coiled shape.

[0007] ~~The~~ An end part of enameled wire 1 forming the coil 1a is soldered to the terminal 4 after the insulating film 1c is stripped.

[0008] ~~Generally~~ A generally practiced process of ~~the~~ soldering ~~is;~~ is ~~either~~ either: stripping the insulating film 1c using a CO_2 laser or the like before soldering, and then soldering the ~~wire;~~ wire; or ~~conducting the~~ performing stripping and ~~the~~ soldering at the same time using a laser beam.

[0009] A method where ~~the process steps of~~ stripping the insulating film 1c and soldering of the wire are ~~made~~ performed simultaneously with a laser beam is described below with reference to FIG. 7.

[0010] A conventional soldering apparatus consists mainly of a laser oscillator 10, an optical fiber 11, a projection lens 12 and a solder string ~~solder~~ 13. ~~Laser~~ A laser beam from the laser oscillator 10 is led via the optical fiber 11 to the projection lens 12 to be projected to ~~the outside~~ an exterior thereof. The ~~irradiated~~ laser beam is absorbed by the land of terminal 4 and the enameled wire 1, and the beam is converted into thermal energy. When the land of terminal 4 is heated to reach a solder melting temperature, the solder string ~~solder~~ 13 is delivered thereto. ~~The heat~~ Heat energy provided for soldering removes the hot-melt layer 1d and the insulating film 1c ~~away~~ by melting, evaporation or sublimation, and solders the enameled wire 1 to the land.

[0011] In the above-described method of soldering, where ~~the covering~~ an insulating film and hot-melt layer are stripped away prior to soldering, cost of bonding tends to increase because of ~~the~~ increased process ~~step of~~ steps required for soldering. In addition, ~~the~~ a CO_2 laser used for stripping the insulating film 1c readily oxidizes the land, and as a result, ~~the~~ a wetting property of the land against solder deteriorates.

[0012] ~~While in the~~ In a method where stripping of insulating film 1c and soldering of wire 1 are conducted simultaneously by laser beam irradiation, since ~~the~~ a normally-used core wire 1b of enameled wire 1 is as fine as 0. 1 mm in diameter, the enameled wire 1 easily breaks by a slightly

increased output of ~~the~~ a laser beam which leads to an excessive generation of heat energy. On the other hand, if ~~the~~ heat energy is insufficient, the insulating film 1c is stripped imperfectly, which tends to cause soldering troubles such as a tunneling solder, or the like.

[0013] As described in the foregoing, a conventional soldering method using a laser beam has a drawback in that it ~~accompanies~~ requires a precise process control.

[0014] The present invention addresses the above problems and aims to provide an enameled wire with which a time needed for laser-soldering a wire on a soldering land can be shortened, and a rate of occurrence of ~~the~~ tunneling solder and other soldering troubles can be decreased. The present invention also includes a method of soldering ~~the~~ an enameled wire, as well as a soldering apparatus using the enameled wire of the present invention.

~~DISCLOSURE~~ SUMMARY OF THE INVENTION

[0015] In an enameled wire of the present invention, ~~the~~ an insulating coated layer is colored for a better absorption of a laser beam, while ~~the~~ a hot-melt layer is transparent to the laser beam. When soldering an enameled wire of the present invention with a laser beam, the insulating coating ~~film~~ layer can be stripped away without making output of ~~the~~ a laser very high, since ~~an~~ absorption ~~against the~~ of an irradiated laser beam is high in the insulating coated layer. As a result, a trouble of a broken enameled wire can be avoided, and ~~the~~ reliability ~~in~~ of soldering between ~~the~~ an end of the enameled wire and ~~the~~ a soldering land is improved.

[0016] An electro-acoustic transducer of the present invention includes a vacant space provided in a resin molded body at least in a part underneath ~~the~~ a soldering land. With an electro-acoustic transducer of the present invention, ~~the~~ efficiency of laser beam utilization increases and soldering quality and ~~the~~ reliability improve.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. 1 is a cross sectional view of an enameled wire having an insulating coated layer in accordance with an exemplary embodiment of the present invention.

[0018] FIG. 2 is a perspective view used to describe ~~a~~ soldering of the enameled wire by laser beam irradiation.

[0019] FIG. 3 is a perspective view showing a relationship between size of a soldering land and diameter of a laser beam spot.

[0020] FIG. 4 is a perspective view of a molded resin case provided in accordance with another exemplary embodiment of the present invention.

[0021] FIG. 5 is a cross sectional side view of a conventional sounder.

[0022] FIG. 6 is a cross sectional view of a conventional enameled wire.

[0023] FIG. 7 is a perspective view ~~used to describe~~ describing how soldering is ~~made~~ performed using ~~a~~ laser beam irradiation.

~~BEST MODE FOR CARRYING OUT THE INVENTION~~

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0024] An enameled wire 21 in accordance with the present invention, a method of soldering the enameled wire, as well as ~~the~~ a soldering apparatus, are described in the following with reference to FIG. 1 through FIG. 4. ~~The portions~~ Portions using the same conventional technology are represented by the same reference numerals used for the prior art, and descriptions ~~to~~ of such portions are omitted. The enameled wire 21 is wound into a ~~a~~ coil through a conventional technology, so description ~~on~~ of a coiling method is omitted here.

First Embodiment 1

[0025] FIG. 1 shows a cross sectional view of an enameled wire manufactured in accordance with an exemplary embodiment of the present invention. FIG. 2 is a perspective view showing how the wire is soldered. FIG. 3 is a perspective view used to show a relationship between size of a soldering land and diameter of a laser beam spot. ~~These drawings relate mainly to the embodiments relevant to claim 1 through claim 9 of the present invention.~~

[0026] Referring to FIG. 1, an enameled wire 21 comprises a core wire 21a made of copper or a copper alloy, an insulating coated layer 21b of colored polyurethane resin covering ~~the~~ an outer surface of core wire 21a, and a transparent hot-melt layer 21c covering ~~the~~ an outer surface of the insulating coated layer 21b.

[0027] A method of soldering the above-configured enameled wire 21 on ~~the~~ a land of terminal ~~4~~ 14 by ~~means~~ virtue of laser irradiation is described referring to FIG. 2.

[0028] In FIG. 2, a land 22 is made of a thin metal sheet, and is provided with a soldering portion 22a. A molded resin case 23 is formed integrally with a terminal ~~4~~ 14 so that ~~the~~ a surface of land 22 is exposed to ~~the outside~~ an exterior of the case.

[0029] ~~Soldering~~ A soldering experiment was conducted with the enameled wire 21 of the present invention using a CO_2 laser under specific laser irradiation conditions. In the experiment, stripping of the insulating coated layer 21b and ~~the~~ soldering were ~~done~~ performed simultaneously. Results of the experiment show that there was no soldering problems (number of samples : N = 300).

[0030] Whereas, in the same experiment conducted under the same conditions using a conventional enameled wire, one sample was rejected due to bad soldering (N = 200). Thus, it has been confirmed that ~~the connection~~ soldering trouble was eliminated by the use of an enameled wire 21 of the present invention.

[0031] ~~Supposed~~ A supposed reason for the eliminated soldering trouble is that color of the insulating coated layer 21b in the present exemplary embodiment is green, while ~~the~~ insulating film 1c of conventional enameled wire 1 ~~has a color that~~ is transparent to the laser beam. Stated otherwise, where the insulating film 1c of the conventional enameled wire 1 is transparent to a laser beam, the insulating coated layer 21b of the enameled wire 21 of the invention is non-transparent to the laser beam. The green-color insulating coated layer 21b efficiently absorbed ~~the~~ an irradiated laser beam; as a result, ~~it~~ the insulating coated layer was surely melted and stripped away, and the core wire 21a of enameled wire 21 had ~~a~~ good contact with molten solder. This seems to be a reason why the enameled wire 21 and the soldering portion 22a are connected in a stable manner.

[0032] Although the insulating coated layer 21b in the present embodiment has a green color ~~green~~, ~~those~~ blue-colored ~~films~~ layers also exhibited the same effects. Thus, ~~the~~ colors given to the insulating coated layer 21b help ~~increasing the~~ increase absorption of a laser beam ~~and~~ so as to heat ~~the film~~ this layer effectively. It seems that an insulating coated layer 21b was melted and stripped away thoroughly, and ~~the~~ soldering finished well, by taking advantage of the above-described factors, without irradiating a high amount of laser beam energy.

[0033] An insulating coated layer 21b may be colored by any conventional ~~means~~ manner using a dye or a pigment. ~~The~~ An absorption wavelength of such coloring ~~means~~ is not required to be ~~existing~~ existent within ~~the~~ a range of visible lights. Namely, ~~the~~ coloring is effective also ~~to the~~ for a YAG laser, CO_2 laser or other kinds of ~~laser beams~~ lasers whose oscillation wavelength is not within the range of visible lights. In this case, the insulating coated layer should be provided with ~~a~~ coloring ~~means~~ that has an absorption band corresponding to ~~the~~ this oscillation wavelength.

[0034] Although in the present embodiment a CO_2 laser apparatus was used because of its general availability and ~~a~~ high energy, high output semiconductor lasers may of course be used instead, which oscillate beams in red, green, ultraviolet or other colors.

[0035] It is to be noted too, that once ~~the~~ melting/stripping is initiated at a part of insulating coated layer 21b, ~~the~~ a stripped area is expanded by ~~a~~ molten solder, and as a result ~~the~~ soldering can be completed well.

[0036] Furthermore, as shown in FIG. 3, when a soldering portion 22a of land 22 is made to have a same shape as that of laser beam spot 24, unwanted heat diffusion can be avoided to obtain a highest heating efficiency. This leads to a shorter soldering time.

[0037] Still further, ~~the~~ soldering time can be shortened by making ~~the~~ a size of ~~the~~ soldering portion 22a of land 22 approximately identical to that of ~~the~~ laser beam spot 24. Under such a configuration, ~~the~~ heat diffusion can be suppressed and ~~the~~ heating efficiency ~~maximizes~~ is maximized.

Second Embodiment

[0038] FIG. 4 is a perspective view of a resin case of a receiver provided in accordance with another exemplary embodiment of the present invention. ~~It~~ FIG. 4 shows how soldering is ~~made~~ performed on a soldering land which is made of a thin metal sheet molded in ~~the~~ resin. ~~The drawing relates mainly to claim 10 of the present invention.~~

[0039] Referring to FIG. 4, a molded resin case 26 is provided with an empty space 26a underneath a soldering portion 25a of land 25. The empty space 26a is provided in order to suppress ~~a~~ diffusion of heat, caused by a laser beam spot irradiation, into the resin ~~casing~~ case 26, and to further increase ~~the~~ efficiency of soldering. The empty space 26a may ~~be penetrating~~ penetrate

through the resin ~~casing~~ case 26 to a bottom surface, in which case, ~~it~~ the empty space can be utilized also as a screw hole for fixing a member to the resin case.

[0040] There can be another ~~means~~ manner for improving ~~the~~ heating efficiency, and hence shortening ~~the~~ soldering time. ~~The land~~ Land 25 may be plated with ~~a~~ solder or tin, or provided with a flux layer on ~~the~~ a surface to increase ~~the~~ a laser beam spot absorption. By so doing, ~~the~~ reliability of soldering may also be improved.

[0041] Though, in the foregoing descriptions only a hot-melt layer of an enameled wire has been explained, it should be noticed that ~~the~~ this melting layer is not limited to a hot-melt type. The present invention may employ enameled wires having a melting layer which is softened or glued by a solvent, or a self-adhesive layer can be used for the same purpose. Also, in the foregoing descriptions the hot-melt layers have been described to be transparent to the laser beam spot. However, it is not ~~requested~~ required that the layer is totally transparent; but, what is essential is that a hot-melt layer absorbs less of a laser beam ~~spot relative to~~ than does an insulating ~~coating film of the wire~~ coated layer surrounded by the hot-melt layer.

[0042] A soldering method ~~in~~ of the present invention can be applied on ~~those~~ enameled wires having no melting layer.

INDUSTRIAL APPLICABILITY

[0043] An enameled wire having an insulating coated layer in accordance with the present invention can be stripped of the insulating coated layer efficiently by a laser beam spot irradiation during a soldering process. As a result, ~~the~~ stripping of the insulating coated layer and ~~the~~ soldering can be conducted ~~simultaneously; that means that the~~ simultaneously, whereby use of an enameled wire of the present invention can shorten a time needed for ~~a~~ soldering ~~work~~ during assembly of an apparatus. Problems due to bad soldering, such as a tunneling soldering, can also be reduced. Thus, the enameled ~~wires~~ wire of the present invention ~~are~~ is expected to make a significant contribution in ~~the~~ manufacturing productivity as well as in ~~the~~ reliability of electric devices including ~~the~~ electro-acoustic transducers and the like.